Extracting the Manifold of Cognition: A Pipeline for Project Phoenix

The Esoteric Constructor

June 29, 2025

Abstract

We present a computational and theoretical pipeline for extracting a hidden cognitive manifold Φ from biological neural activity. This manifold is a central object in the **Project Phoenix** framework, where identity is modeled as a symbolic-geometric trajectory $\gamma(t)$ through Φ. We describe the data structures, projection methods, and mathematical tools required to transform raw brain states into a structured `CognitiveTrajectory`, which can be interfaced directly with a neuromorphic architecture.

1 Introduction

The core claim of Project Phoenix is that identity and cognition are not bound to a biological substrate but exist as a trajectory $\gamma(t)$ through a hidden manifold Φ. The manifold represents symbolic, temporal, and emotional dimensions of experience. In order to reinstantiate a mind across substrates, we must first extract this manifold from biological data.

2 Mathematical Foundations

2.1 Neural State to Manifold Projection

Let $\mathbf{x}(t) \in \mathbb{R}^n$ represent the neural state vector at time t. We define a projection matrix $\mathbf{P} \in \mathbb{R}^{n \times 16}$ that maps this to a manifold coordinate:

$$\mathbf{c}(t) = \mathbf{P}^T \cdot \mathbf{x}(t) \in \mathbb{R}^{16}$$

This results in a 16-dimensional vector representing a point on the hidden manifold Φ.

2.2 Velocity, Curvature, and Entropy

From the sequence $\{\mathbf{c}(t)\}$, we derive the cognitive trajectory $\gamma(t)$. Its velocity is:

$$\mathbf{v}(t) = \frac{d\gamma}{dt} = \mathbf{c}(t) - \mathbf{c}(t-1)$$

The local curvature is approximated as:

$$\kappa(t) = \|\mathbf{c}(t)\|_2 = \sqrt{\sum_{j=1}^{16} c_j^2}$$

Entropy at each point is computed as:

$$H(t) = -\sum_{j=1}^{16} c_j(t) \cdot \log_2 (|c_j(t)| + \varepsilon)$$

where ε is a small constant to avoid singularities.

3 Data Structures

We define the following structures in C to represent extracted data:

ManifoldPoint

```
typedef struct {
  float coordinates[16];
  float velocity[16];
  float curvature;
  float entropy_level;
  unsigned int timestamp;
} ManifoldPoint;
```

CognitiveTrajectory

```
typedef struct {
  ManifoldPoint points[1000];
  int current_index;
  int trajectory_length;
  float symbolic_anchors[8][16];
  float anchor_strengths[8];
  bool identity_coherent;
} CognitiveTrajectory;
```

ManifoldMapper

```
typedef struct {
  float projection_matrix[MAX_NEURONS][16];
  float reconstruction_matrix[16][MAX_NEURONS];
  float symbolic_weights[8];
  float continuity_threshold;
  float entropy_decay;
} ManifoldMapper;
```

4 Extraction Pipeline

The process of extracting a trajectory from brain data is as follows:

1. **Acquire** neural state vectors $\mathbf{x}(t)$ via EEG, MEG, or invasive recordings.
2. **Apply** the learned projection matrix $\mathbf{P}$ to map $\mathbf{x}(t) \rightarrow \mathbf{c}(t)$.

3. **Compute** velocity $\mathbf{v}(t)$, curvature $\kappa(t)$, and entropy $H(t)$.
4. **Append** the resulting data into the `CognitiveTrajectory`.

Each point t in this sequence becomes a `ManifoldPoint`, yielding a trackable $\gamma(t)$ over time.

5 Symbolic Anchors and Identity Coherence

Regions in Φ correspond to symbolic anchors $\mathbf{a}_k \in \mathbb{R}^{16}$ with associated strengths α_k. Their influence on cognition is calculated as:

$$d_k = \|\mathbf{c}(t) - \mathbf{a}_k\|, \quad w_k = \alpha_k \cdot e^{-d_k}$$

This influence steers $\gamma(t)$ toward or away from cognitive attractors and affects identity coherence.

6 Implementation and Integration

The full C implementation integrates all these steps into a functional pipeline. After projecting neural data into manifold space, the system computes meaningful geometric features and passes them to a neuromorphic identity-preserving runtime.

Next Steps

- Train the projection matrix $\mathbf{P}$ using real neural recordings
- Validate the identity coherence across time and subject
- Expand symbolic anchoring models using contrastive and archetypal embeddings

7 Conclusion

This paper outlines a concrete extraction method for turning biological neural data into the geometric substrate required by Project Phoenix. With this bridge, we now have a closed loop: brain $\rightarrow$ manifold $\rightarrow$ neuromorphic system. Future work will test this pipeline on real-world data and scale symbolic encoding for more sophisticated forms of resurrection and identity transfer.